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ICT Roadmaps to Enhanced Sustainability

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Contents

ICT Roadmaps to Enhanced Sustainability

Definition and Context

Subject to the whims of politics and economics, enthusiasm for sustainability policy, programs and projects has followed a precarious path. In the technology field, the 'green IT' movement of the early part of this century stumbled on the grim realities of the 2008 global economic crisis, when belt tightening – as opposed to new investment in clean tech – was viewed as the ultimate survival technique. More recently, greater social awareness of the impacts of carbon emissions and resource shortages has begun to emerge, driven by climate science, millennial interest and better economic prospects, as well as by climate events that are increasing in frequency and intensity. Reflected in renewed political commitment, seen, for example, in the China and US ratification of the Paris Climate Change Agreement of 2016[1], government support in Europe, Canada and elsewhere for cap and trade[2] and carbon tax schemes[3], emerging awareness was demonstrated in "green" infrastructure investment and financial incentives to support business and citizen's resource conservation activities.[4] Recent reversals on environmental policy by governments in the US and Canada, notably the current US administration's withdrawal from the Paris Climate Agreement and the Ontario government's departure from the Western Climate Initiative (cap and trade system)[5], have slowed this momentum; however, the vacuum left by politically driven policy making is being filled, at least partially, by other organizations, including regional and city governments[6], or in Canada's case, by the federal government, which is working – with mixed results[7] – to align provincial environmental programs and carbon reporting in the

[1] Mythili Sampathkumar. Here's Why You're Hearing About The Paris Climate Change Agreement Again. Good. September 2016. https://www.good.is/articles/explainer-everything-you-need-to-know-about-the-climate-change-agreement

[2] Cap and trade. Government of Ontario. https://www.ontario.ca/page/cap-and-trade

[3] Ross Beaty, Richard Lipsey and Stewart Elgie. The Shocking truth about B.C.'s carbon tax: It works. Globe and Mail. July 2014. http://www.theglobeandmail.com/opinion/the-insidious-truth-about-bcs-carbon-tax-it-works/article19512237/

[4] Investing in the Low-Carbon Economy. Ontario Ministry of Finance. http://www.fin.gov.on.ca/en/budget/ontariobudgets/2016/bk4.html

[5] Paola Loriggio. Doug Ford takes step to dismantle cap and trade, officially winds down green programs. The Globe and Mail. July 3, 2018. https://www.theglobeandmail.com/canada/article-doug-ford-to-officially-wind-down-green-programs-funded-through-cap/

[6] COP23: Cities and local governments for climate action. European Commission. November 13, 2017. Angel Hsu and Amy Weinfurter.
All Climate Politics Is Local. After Trump's Paris Withdrawal, Subnational Groups Have Stepped Up. Foreign Affairs. September 24, 2018. https://www.foreignaffairs.com/articles/united-states/2018-09-24/all-climate-politics-local

[7] Office of the Auditor General of Canada. Perspectives on Climate Change Action in Canada—A Collaborative Report from Auditors General—March 2018. http://www.oag-bvg.gc.ca/internet/English/parl_otp_201803_e_42883.html

Pan-Canadian Framework.[8] The private sector has also stepped up its game, with technology companies in particular assuming a leadership role by establishing impressive targets for emissions reduction, and executing on sustainability strategy through the development of highly innovative approaches to carbon emissions management in operations, and through the creation of low-impact products and services.

For some of these firms, sustainability initiatives are one component of CSR programs aimed at neutralizing negative perceptions of the business that emerged with media scrutiny of operational practices. A shift to reliance on renewable energy sources by the hyperscale cloud service providers, for example, was inspired in large part by green activist groups and media accounts of the carbon impact of large cloud "factories."[9] Certainly the information and communications technology industry has much to account for in terms of its carbon impact. Today, research into the end-to-end energy consumption of ICT – covering devices to access, core, transport networks and data centers – has found that the industry accounts for approximately 1.6 percent of global GHG emissions, and with growing deployment of ICT, will account for 2 percent of the total in 2020.[10] According to the seminal SMART 2020 report[11], released by the Global e-Sustainability Initiative in 2008, 2 percent is roughly equivalent to the impact of the airline industry, and if increases have not been as rapid as originally forecast – due to recession and ICT efficiency improvements – IT environmental impact is nevertheless significant. But an even more interesting finding in GeSI research is the potential for ICT to produce carbon reduction improvements in other sectors of the economy – GHG reduction improvements in the so called "other 98" that GeSI estimated in a subsequent report[12] would be 16.7 percent – or approximately eight times the impact of ICT itself.

*The SMART 2020 report found that ICT can produce carbon reduction improvement in other sectors of the economy…**equivalent to 8 times the impact of ICT itself***

[8] Government of Canada. PAN-CANADIAN FRAMEWORK ON CLEAN GROWTH AND CLIMATE CHANGE. First Annual Synthesis Report on the Status of Implementation – December 2017. https://www.canada.ca/content/dam/themes/environment/weather/climatechange/PCF-FirstSynthesis_ENG.pdf

[9] Gary Cook and Jodie Van Horn. How dirty is your data? A Look at the Energy Choices That Power Cloud Computing. Greenpeace International. April 2011. http://www.greenpeace.org/international/Global/international/publications/climate/2011/Cool%20IT/dirty-data-report-greenpeace.pdf
James Glanz. Power, Pollution and the Internet. New York Times. September 2012. http://www.nytimes.com/2012/09/23/technology/data-centers-waste-vast-amounts-of-energy-belying-industry-image.html?_r=0

[10] Ericsson. Assessing ICT sector carbon footprint. https://www.ericsson.com/about-us/sustainability-and-corporate-responsibility/energy-environment-and-climate/assessing-ict-sector-carbon-footprint

[11] SMART 2020: Enabling the low carbon economy in the information age. The Climate Group on behalf of the Global eSustainability Initiative. 2008. http://gesi.org/files/Reports/Smart%202020%20report%20in%20English.pdf

[12] GeSI SMARTer2020: The Role of ICT in Driving a Sustainable Future. 2012. http://gesi.org/portfolio/report/72

So what are the sources of ICT impact and its abatement potential? As one member of the ICT Roadmaps to Enhanced Sustainability working group advised, the question of impact can be viewed through a broad lens. A commonly accepted definition of sustainability, advanced by Gro Harlem Brundtland back in the 1980s focused on development goals: sustainable development is development that meets the needs of the present without compromising the needs of future generations to meet their own needs."[13] Similarly, the Triple Bottom Line approach to sustainability takes into account the interplay of economic, social and environmental inputs in assessing sustainability outcomes. In an ICT context these factors also come into play: advanced technology solutions can enable better financial performance and enhanced social welfare and justice (closing the 'digital divide'), while at the same time addressing environmental challenges – with progress in each area reinforcing success in the others to achieve broad sustainability of human and planetary systems. But the key to ICT potential to mitigate the primary sustainability issue of our times – climate change – lies in the energy equation: consumption of power generated through fossil fuel production by devices and data centres, and ICT ability to support reduced consumption of energy and other resources in other sectors.

According to the working group, ICT can support environmental sustainability in three ways: through deployment of increasingly efficient ICT devices and components, including data centre technologies such as cloud computing; through dematerialization, which in 'tech speak' refers to replacement of physical or manual processes with digital systems, as in telecommuting; and through the application of ICT to optimize business processes and improve efficiencies in other sectors. Technology advance has created additional opportunity for carbon and other resource savings today: specifically, the ubiquity of advanced, high speed connectivity has enabled the development of intelligent ecosystems, such as Smart City or Intelligent Industry, that rely on the collection and analysis of vast amounts of data to monitor and control the built and natural worlds. In addition, growing capacity not only to collect and transit data, but to store, analyze, and correlate data in new ways, and to view it via presentation layers that democratize insight by creating broader accessibility and greater ease of use, can have a profound effect on ICT's ability to enhance sustainability. These kinds of benefits are already being captured: applications in the sharing economy, such as Uber, for example, rely on software that reduces waste by organizing resource pooling to achieve better utilization of cars and drivers.

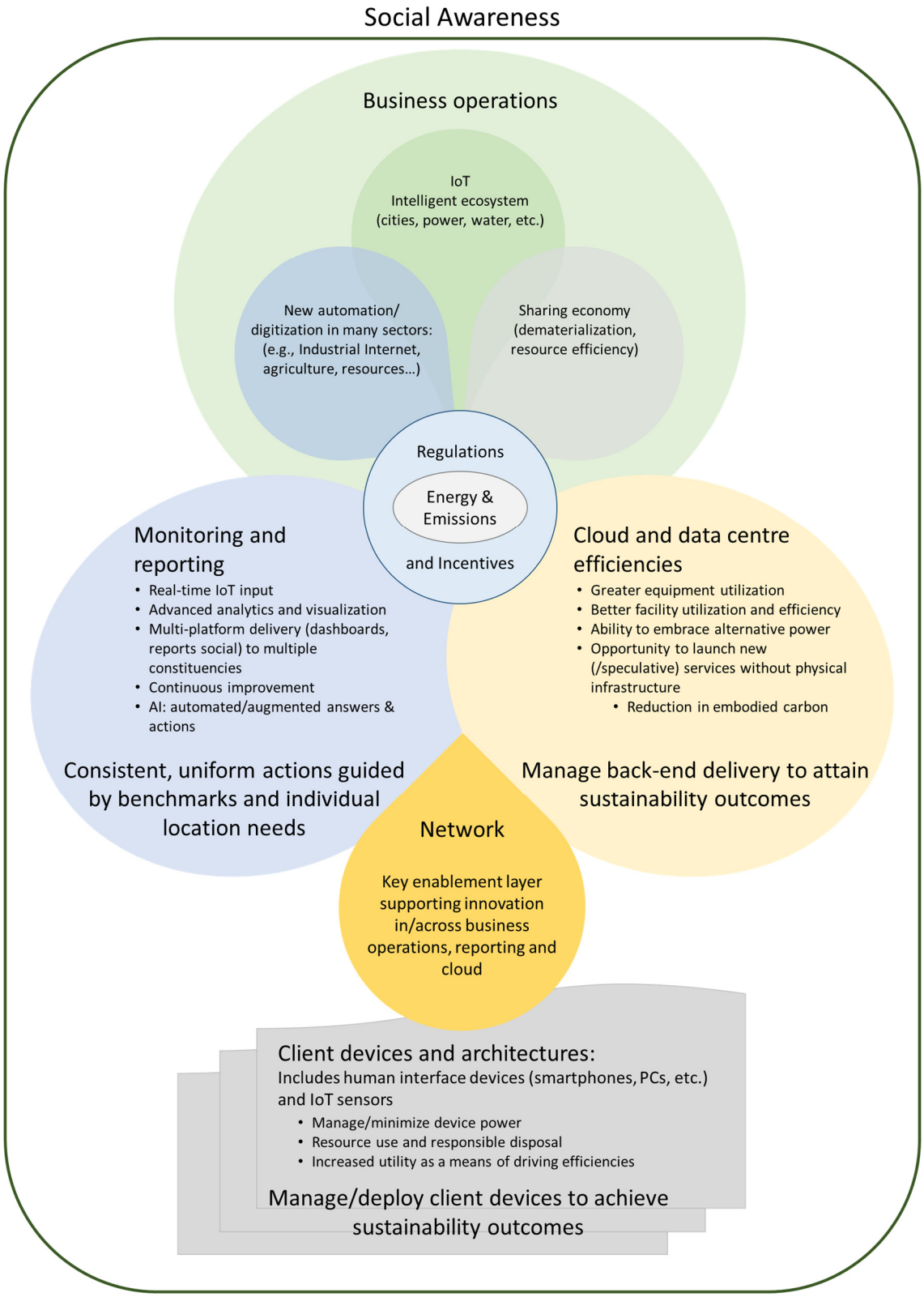
Going forward, the working group believes that measurement capability will be critical to maintaining ongoing dialogue and activity around ICT support for enhanced sustainability. Advanced measurement capabilities will draw on each of the components in the ICT stack, particularly analytics and information management, the creation of networks that can handle real time data streams, and automated reporting functionality. They will act as a new driver for sustainability, extending beyond reinforcement of regulatory or NGO reporting (e.g., CDP or GRI reports) to provide inputs needed to support KPIs and enable real time decision making and system adjustments in many new environments.

Ultimately, improved measurement performs two functions. While it enables the ability to react to need for change in real time, improving processes to enhance productivity and sustainability, it also delivers a consistent set of reports that can be used internally by the organization in tandem with financial metrics

[13] United Nations. Report of the World Commission on Environment and Development. Our Common Future. 1987. http://www.exteriores.gob.es/Portal/es/PoliticaExteriorCooperacion/Desarrollosostenible/Documents/Informe%20Brundtland%20(En%20ingl%C3%A9s).pdf

to ensure sustainability initiatives also offer economic benefit. Reporting provides a credible source to help an investor, policy maker, regulator or consumer make informed choices based on sustainability performance. And by distributing this intelligence, better reporting helps to drive social awareness of issues, align sustainability activity with the organization's financial goals, and push the needle on environmental responsibility – the triple bottom line.

Figure 1. Key components of sustainable technologies and technology-enabled processes



Source: TCBC/InsightaaS, 2018

Business Objectives

Sustainability touches virtually every aspect of virtually every business; as a result, it is difficult to highlight a discrete set of specific business objectives that prompt investment in sustainability overall, or that position sustainability as a technology investment driver. At the highest level, businesses can be said to invest in technology to achieve one or more of four primary outcomes: reduced cost, increased revenue, increased profitability and/or improved shareholder value. The working group identified each of these as legitimate objectives associated with sustainability. And it has been suggested that the inverse also holds – that the pursuit of sustainability objectives can in fact generate these outcomes. Recent research on sustainability investment has found, for example, that firms that are aligned with environmental, social and governance standards are more competitive than their peers and show higher profitability.[14]

There is a great deal of evidence to support the notion that sustainability initiatives result in *reduced cost.* More efficient equipment, for example, reduces electricity costs; in the data centre, it also reduces environmental impacts (including emissions and water) associated with power generation, aligning economic and environmental objectives. Beyond direct impact, there are many examples of how ICT-enabled abatement reduces cost and improves environmental performance: for example, a power company could use comparative data drawn from its plants (and potentially, other companies' plants as well) to identify opportunities for more efficient operations reducing both cost and emissions, or a pulp mill may find that sensors used to identify pollution sources also highlight maintenance requirements that will ultimately decrease costs from equipment failure and plant downtime.

Increased revenue is harder to attribute directly to sustainability-focused investments in IT, but there is evidence that consumers will gravitate towards brands with a strong commitment to sustainability, and the tracking systems needed to demonstrate environmental success – plus the positive impact of reduced Scope 2 emissions from use of more efficient technology and/or the cloud – is fundamental to establishing a connection to sustainability-focused buyers.

Improved profitability is generally derived from efficiency – by increasing sales faster than cost, or by reducing costs without negatively affecting revenue. As shown above, investments in sustainable IT can aid both objectives. Additionally, though, the working group noted that sound environmental monitoring helps 'lock in' profit by reducing or eliminating the prospect that an organization will need to take remedial clean-up actions in the future.

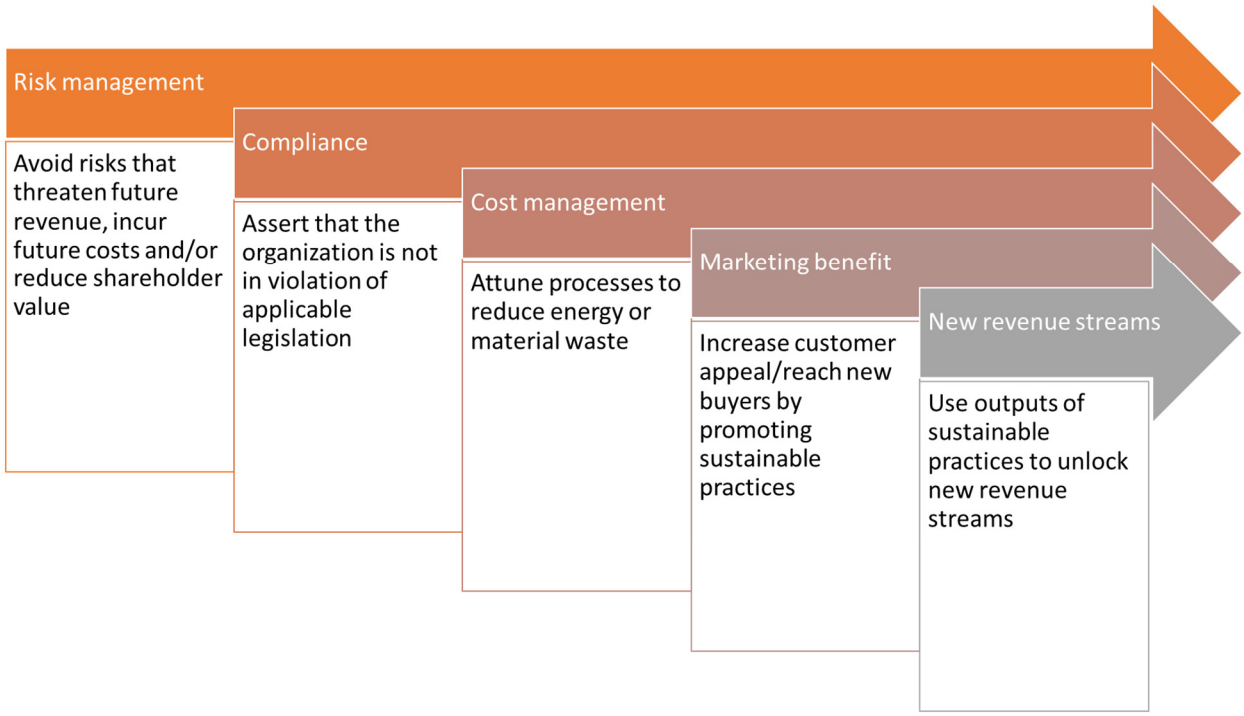
Finally, *shareholder value* links to investments in and use of sustainable systems in several ways. Many of these are listed above, but the working group had additional examples of how sustainable practices and technologies can provide additional shareholder benefit. One important example is in the area of investors focused on sustainability and environmental performance as key criteria. Firms with strong environmental track records are able to access funds that are not available to firms that are unable to demonstrate sustainability success, increasing the overall potential for growth in shareholder value.

[14] MSCI Foundations of ESG Investing: How ESG Affects Equity Valuation, Risk and Performance. Nov 2017. P. 8. https://www.msci.com/www/research-paper/foundations-of-esg-investing/0795306949

Aligning key sustainability objectives more closely with technology

While it is possible to identify ways that sustainable technologies and the practices that they support connect with high-level corporate objectives, the working group found that this approach doesn't provide the best basis for categorizing sustainability initiatives. Instead, as is shown in Figure 2, the working group identified a framework that ties a series of connected and escalating goals to specific sustainability objectives.

Figure 2. Sustainable technology business objectives



Source: TCBC/InsightaaS, 2018

Key examples and indicators of alignment with these objectives include:

- Compliance: ICT systems are used to track environmental performance and to demonstrate that the corporation is observing all applicable regulations.
    - *Business outcomes:* Reduce potential for fines or other regulatory actions that incur costs; allow staff to focus on productive tasks rather than responding to regulator queries.
- Risk management: Systems are used to identify and mitigate risks that have material financial impacts on current and future results.
    - *Business outcomes:* Identify issues (e.g., contaminants released by aging or ineffective industrial plants/processes) that may expose the organization to future penalties or reduce the value/salability of assets (e.g., land); stay 'in front of the news' by understanding and addressing issues before they are exposed via social media or other means.

- Cost management: Use equipment and processes that reduce energy, embedded impact or material waste.
    - *Business outcomes:* Reduce energy used by IT equipment; engage in sustainable design to better manage materials use in IT components (plastics, metals, conflict-free minerals); use IT-based control systems (e.g., IoT systems) to reduce energy or emissions through 'smart' infrastructure, buildings, transportation, etc.; use IT-powered production equipment to reduce material lost in production, transportation, or elsewhere in the value/supply chain.
- Marketing benefit: Positive sustainability outcomes are captured, quantified and (in at least some cases – for example, via social media or other electronic communications) promoted via ICT systems.
    - *Business outcomes:* Document and publicize sustainability success to target markets, including consumers, supply chain partners, regulators and shareholders who differentiate between competitors based on achievement of sustainability objectives; increase appeal to customers/new buyers and potential new hires looking for a responsible employer.
- New revenue streams: Monetize data captured as part of sustainability initiatives.
    - *Business outcomes:* Provide data on efficiency, emissions or other environmental benefits to customers as a value-added service; use sustainability-related data (e.g., on fuel consumption) as the basis of new contract models that align billing with efficiency.

Scenarios discussed by the working group make it clear that these objectives often work together: for example, a power plant that captures data on emissions can use that data to satisfy regulators and also to identify at-risk processes or equipment; analysis based on multiple generation sources can be used to identify suppliers or operational practices that improve efficiency; improved efficiency can in turn be marketed to customers who incorporate this data in their own emissions reporting and marketing activities; the data can also be provided to suppliers, competitors (via some form of consortium) or other parties as a source that has value in its own right.

The working group observed that buyers often go through a sequence of positions with respect to the regulations that establish compliance standards at the beginning of this process. Typically, the group observed, suppliers push back on regulations, claiming that they add cost and complexity, and then progress to viewing new systems as a marketing boon, one that can lead to unforeseen opportunity. One example of this is found in automotive safety systems: car manufacturers initially pushed back against seatbelt and airbag regulations; later, companies promoted effective systems, now including guidance and sensors as well as restraints, as differentiators for their products; still later, companies are finding ways of monetizing system output, by selling information on driver destinations and driving habits to insurers, advertisers and other interested parties.

At its core, this process is launched by a need to deploy measurement devices (seat occupied, seatbelt engaged, tires and brakes functioning, etc.) and expand in relevance and potential with the addition of analysis (anti-lock braking or traction control that responds to road conditions, directions that reflect traffic conditions, etc.). With the massive increase in sensor data generated by IoT, and the increased capacity to combine and analyze data when it reaches the cloud, there are manifold new opportunities for sustainable IT systems that affect everything from the power used by individual electronic devices to

data centres, and from homes to cities to grids, watersheds…all aspects of energy and material extraction and use.

Assessing the business objectives associated with key components of sustainable technologies and technology-enabled processes

To add depth to the discussion of sustainability-linked business objectives, the working group considered the five items highlighted above – compliance, risk management, cost management, marketing benefit and new revenue streams – as a continuum of benefits. The group then drilled down into how these objectives apply to the sustainable technologies and technology-enabled processes shown in Figure 1, looking for a double-bottom line connecting economic and sustainable benefits. The resulting analysis provides fascinating insight into how businesses can align sustainable technology activity areas with compelling business outcomes.

Benefits associated with sustainable business operations

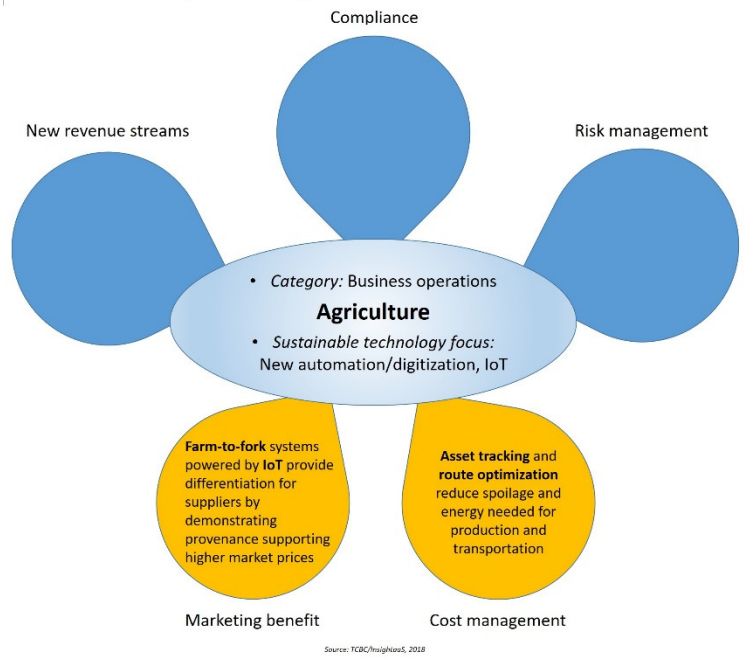
The category of 'business operations', as defined in Figure 1, refers to new automation/digitization in sectors like agriculture and resources, IoT-enabled intelligent ecosystems applied to complex systems such as cities, power and water, and 'sharing economy' activities that provide for sustainability-related outcomes like dematerialization or improved resource efficiency. The working group developed five sector-level perspectives to demonstrate the benefits that are realized through sustainable business operations.

New automation/digitization

Agriculture

The examination of the sustainability impact of automation and digitization started with a discussion of the application of these technologies to agricultural processes. The group believed that the use of asset tracking and route optimization technologies will yield sustainability and cost management benefits in agriculture by reducing spoilage and energy (and related emissions) used to bring in and transport agricultural products.

Figure 3. Advanced technology and sustainability business objectives: New automation/digitization in agriculture

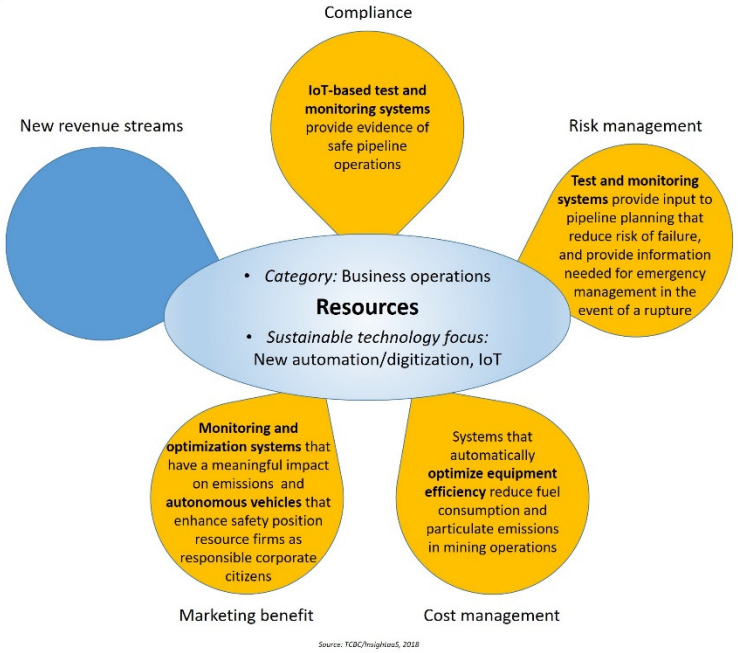


Farm-to-fork systems offer an example of how technologies that advance sustainability in agriculture also provide marketing benefit. IoT-based systems that deliver visibility into the source and handling of foods purchased in a city store reward responsible suppliers by providing differentiation (demonstrating provenance, organic and local sourcing, and providing a proxy for quality) that supports higher market prices.

Resources

There are numerous areas in oil and gas – or other areas, including mining – where sustainability and business benefits align. Technology advancing beneficial sustainability and business outcomes starts literally at the beginning of the process and beneath the ground: advanced sensing and modelling systems provide a cost and environmentally-beneficial alternative to exploratory drilling, which improves cost (and risk) management.

Figure 4. Advanced technology and sustainability business objectives: New automation/digitization in resources



Test, measurement and diagnostic systems provide business and environmental benefits through the refining and distribution process. Systems that accurately identify risk of failure in pipeline components, for example, reduce legitimate concerns about (and can mitigate objections to) pipeline failure by automating test and diagnostics to prevent (or at least manage) pipeline ruptures. Data collected through test and measurement can support pipeline construction decisions regarding materials and suppliers that improve reliability, reducing costly delays in approvals before the pipeline is constructed and helping operators minimize failure risk, and to avoid the damaging and expensive remediation required in the event of pipeline failure. These systems in turn rely on IoT sensors for the input required by the system.

Like oil and gas, mining operations make extensive use of sensors in systems that contribute meaningfully to both business success and improved environmental performance. The working group cited the example of sensor-based systems that automatically optimize the engine performance of heavy equipment, or the electrification of equipment fleets. These systems reduce diesel consumption, which is a significant cost source for mine operators, and in so doing, produce a meaningful reduction in particulate emissions.

More recently, mining firms have been investing in autonomous vehicles – heavily-instrumented, self-driving equipment. These vehicles yield several different double-bottom line benefits: they improve safety by keeping human operators out of hazardous environments, and the trucks themselves act as sensors, fine-tuning mining activity and reducing waste in mineral extraction.

At a high level, these uses of technology for sustainability purposes yield marketing benefits as well. Resource firms are often the targets of environmental criticism; data and actions that demonstrate responsible corporate citizenship help to differentiate companies that make proactive investments in the areas described above, and are increasingly required in reporting and disclosure documentation that can provide needed information to regulators.

IoT-enabled intelligent ecosystems

Cities

One of the core applications associated with IoT-powered Smart Cities is traffic management systems designed to improve traffic flow. These systems provide risk management on multiple levels – they improve safety for individual drivers and pedestrians, while also reducing system-wide risk of congestion. Traffic management benefits also extend to marketing – cities that can fairly claim to be safer, easier to traverse and less polluted will appeal to tourists and residents.

Other traffic-related systems deliver benefits in different ways. In Boston, for example, drivers are able to report potholes with their smartphones. This helps reduce city maintenance costs (by directing road crews to areas of need) and produces secondary benefits as well: less waste from broken suspension components, improved safety due to drivers not being diverted or distracted by potholes, and greater satisfaction with the public works department. The system itself also creates a new revenue stream for the app developer, which feeds eventually into the tax base.

Figure 5. Advanced technology and sustainability business objectives: IoT-enabled intelligent ecosystems in cities

City-owned vehicles offer additional opportunities for deployment of technologies that deliver environmental and financial benefit. One working group member cited a pilot project in which sensors installed in fleet vehicles provided data on location, emissions and fuel performance. This data can be used for many purposes: it can feed into route optimization systems to reduce fuel use and emissions, it can provide input to procurement strategies by identifying the vehicles that use the least fuel and generate the lowest amount of emissions, and it can provide insight that contributes to better delivery of needed services, such as traffic management and snow removal.

On a broader level, traffic data – and data from other city systems – can be distributed via open data to help cities benchmark operations – e.g., snow removal or waste management efficiency – against comparable entities, and can enable entrepreneurs to develop new applications that provide previously-unavailable (or in some cases, unimagined) options for citizens. Fueling innovation by providing rich data produces new revenue streams within the private sector, which (depending on the location of the entrepreneur) may yield subsequent tax revenues for the municipality.

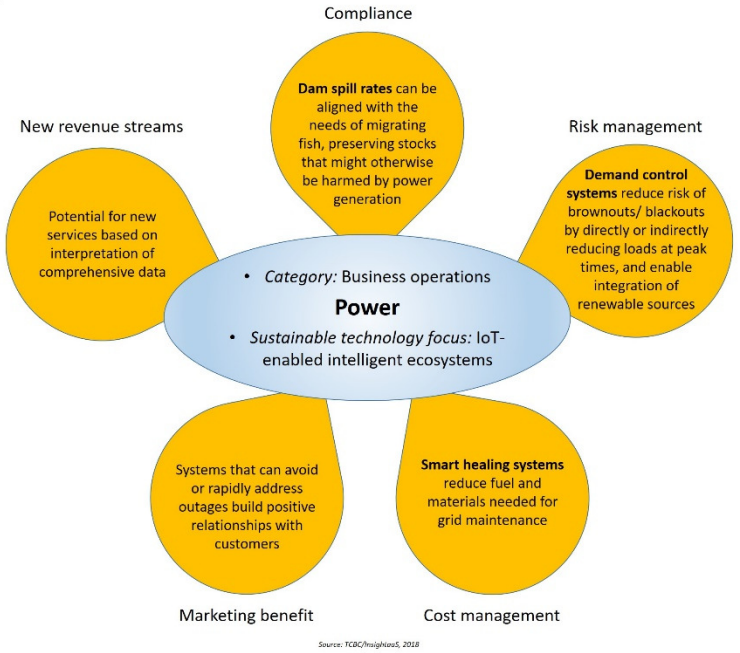
There is a reasonable argument to be made that a Smart Cities focus will increase revenue streams to both the public and private sector. Clean environments are preferred locations for tourists and residents alike, which increases revenue from property and tourism-related taxes; companies that grow up to fill local smart city requirements may find export opportunities as other cities follow down this path.

Finally, as was noted in the Resources section, there is intrinsic marketing benefit to adopting the technologies and technology-enabled processes covered in this section. Municipal governments that are proactive in using technology to improve living conditions for residents while also optimizing use of public funds will benefit from citizen goodwill and buy-in.

Power

Like cities, power grids represent complex environments where networks of sensors feeding sophisticated analytics systems can deliver insights that lead to greater efficiency and improved environmental performance. In its discussions, the working group identified several specific areas where "smart power" delivers double-bottom line benefits.

Figure 6. Advanced technology and sustainability business objectives: IoT-enabled intelligent ecosystems in utilities



The first part of the working group's deliberations focused on compliance. There are many different ways where IoT-based smart ecosystem technologies help power systems to conform to (and demonstrate adherence to) regulatory requirements. One interesting area was in connecting hydroelectric dam water flow to the needs of migrating fish; hydro operators can use monitoring systems to control spill rates, ensuring that fish stocks aren't adversely affected by the power works.

On the risk management front, demand control systems – in which Smart Power systems regulate usage patterns either directly (by adjusting or shutting down appliances) or indirectly (through peak demand billing) – helps the utility to provide continuous power without brownouts/blackouts or the need to invest in new generation capacity. These systems also provide for integration of renewable power sources such as wind and solar.

'Smart healing' systems that identify and route around damaged transmission components deliver risk management benefits, and extend to addressing cost management objectives. These systems reduce fuel and materials needed for grid maintenance by identifying faults while simultaneously removing the need for immediate remediation (by re-routing power supply), allowing maintenance to be scheduled in an orderly, efficient fashion. Smart healing systems also yield marketing benefit, as customers will be happier if systems do not go down during weather events, or if they are rapidly restored to service.

Lastly, though the working group had no concrete examples to cite, there is at least the prospect of new revenue arising from smart power. The net sum of power generation income itself is probably not positively impacted by these systems (though there are examples of situations where gross spending on electricity has increased in the wake of smart meter introductions), but there are new services-based

business opportunities associated with the ability to "make better decisions…methodologies, people, and systems that can properly interpret, manage and predict [demand], and make decisions and changes" that optimize power use across the entire generation, delivery and consumption grid.

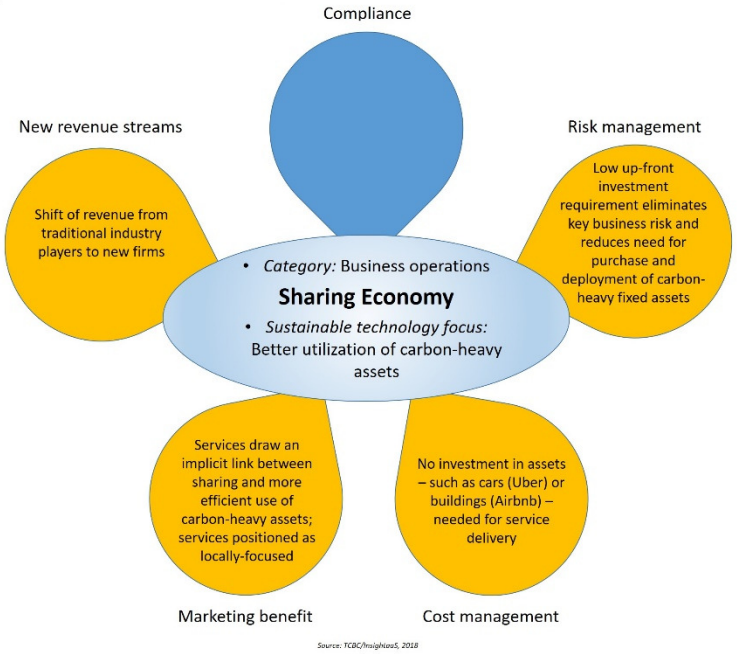
Dematerialization

Sharing economy

Unlike the previous examples, the 'sharing economy' doesn't reference a specific economic sector, but rather, an economic approach – exemplified by Uber and Airbnb – that relies on cloud-based applications to connect individuals looking for a service/access to an asset to those who are looking for opportunities to use their existing assets to satisfy that demand.

There are many examples of cases where the transaction doesn't simply involve excess capacity but rather, assets that have been acquired to capitalize on demand for sharing economy services (e.g., rides in cars that have been purchased to act as Uber vehicles, Airbnb locations that are maintained specifically to house Airbnb-booked travellers). However, there are also unquestionably cases where the delivered service is based on use of an existing asset's excess capacity (a ride in a car that would be otherwise parked, a stay in a spare room or a vacated home or apartment). These scenarios speak to *dematerialization*, or service delivery that avoids the need for a purpose-built asset (here, a taxi or a hotel).

Figure 7. Advanced technology and sustainability business objectives: Dematerialization in the sharing economy



Dematerialization associated with assets like cars and hotels – both of which can be seen as 'carbon-heavy' due to the great deal of *embodied carbon* associated with their manufacture/construction – can have a substantial impact on the environment; research has found that both auto and room sharing could have a positive impact of more than 100 Mt CO_2e per year.[15] Given the enormous potential of dematerialization[16], the working group looked to apply the benefits framework to the sharing economy.

The group was able to quickly identify benefits in the new revenue streams, cost management and risk management categories. Uber and Airbnb are two prime examples of businesses that have realized new revenue streams – for themselves and for the individuals who fulfill the demand that they

[15] Custom research conducted by InsightaaS for a client.

[16] Rides-as-a-Service and personal space are just two of 41 discrete sharing economy categories depicted in the "Collaborative Economy Honeycomb v3.0. Please visit Jeremiah Owyang's Web Strategist blog for more detail: http://www.web-strategist.com/blog/2016/03/10/honeycomb-3-0-the-collaborative-economy-market-expansion-sxsw/

develop/consolidate – by using technology to connect willing buyers and appropriately-equipped service providers. And the companies themselves, and suppliers who don't dedicate purpose-sourced vehicles/lodgings/etc. can realize enormous cost and risk advantages: Uber owns no cars and Airbnb owns no hotels, yet these firms compete successfully with massive, entrenched competitors that have billions of dollars tied up in fixed assets.

The one blanked-out section in this diagram is compliance. One group member noted that sharing economy practice could almost be described as "anti-compliance:" prominent firms like Uber and Airbnb tend not to be subject to regulations and fees (for example, OSHA, commercial operator insurance, employee benefits) that established competitors are required to pay. This complicates a holistic evaluation of the real sustainability of these businesses, as paying fees of this type would greatly erode the pricing advantage that draws consumers to sharing alternatives.

Identifying sustainability business objectives tied to IT systems

Referring back to Figure 1, the final area of discussion on sustainability business objectives concerned IT systems: cloud and data centre, network and client/distributed devices. For the most part, the working group focused on the issues relating to cloud and data centre, including better equipment and facility utilization and efficiency, opportunities to integrate alternative power sources and opportunities to launch new services without deploying physical assets, reducing both embodied and operational carbon.

The working group found that in the main, sustainable objectives aren't primary drivers of data centre strategies. One member noted that while data centre marketing emphasizing 'green' facilities is "not necessarily a selling point any more," though "social awareness of [data centre] efficiency is important to certain segments," notably, government.[17]

Regardless of whether evaluations emphasize sustainability, there is clear evidence that migration to cloud/managed facilities delivers important sustainability outcomes. Cloud/colo/hosting, for systems as well as for common applications (such as Microsoft Office), reduces the need to build, buy, deploy and power a large number of inefficient distributed units, especially within small and medium businesses. Managed facility operators are able to provide feedback to these SMBs from monitoring and reporting systems that are part of the provider's infrastructure, but not likely to be found in smaller environments. And the availability of managed IT services dissuades new businesses from purchasing discrete infrastructure products, positively impacting embodied and operational carbon associated with IT.

It's also the case that some of these new businesses themselves have beneficial sustainability impacts. One example offered by a working group member was home energy monitoring, where suppliers use access to advanced technologies to help homeowners to reduce electricity use.

Alternative power and other conservation options

Despite the (supplier) professed benefits of co-locating data centre facilities near renewable power sources – or integrating alternative power sources into a facility's energy mix via a microgrid – there are few examples of this being a major driver of data centre strategies. Certainly, hyperscale operators (such as Google) have located facilities near hydro dams, and Montreal, with its hydro-heavy power grid mix, has attracted a large number of data centre operators. It's thought, though, that in the case of

[17] This comment was specific to the Canadian federal government, but there are other examples of governments that are committed to including sustainability in their IT supplier evaluations.

Montreal, and to some extent, in other jurisdictions, the key appeal of hydro isn't so much 'a reduction in emissions associated with data centre operations' as 'a reduction in the power costs that can account for 40% of overall OPEX.' Here again, as was the case with data centre monitoring and reporting, sustainability outcomes exist but are not the primary considerations in strategy formulation.

The picture is similar, but brighter, when it comes to efficient operational practices such as 'free cooling.' Most large-scale data centre operators actively pursue advanced cooling and power management technologies that have the effect of reducing data centre power use, and as a result, emissions associated with data centre operations.

Best Practices: Bridging the Abstraction Gap

In the rich examples presented above, the potential for deriving significant business and social benefit from sustainability initiatives is clear. The working group has aligned key technology-based innovations with opportunities for improved sustainability performance across a range of industries that are critical to the health of the Canadian/global economy, including agriculture, manufacturing, the resource and power industries and city government, plus the sharing economy and the IT sector itself, while reinforcing the potential for attendant financial benefits. On the cost front alone, a shift to more carbon friendly activities can have real impact: a 2018 report from the Global Commission on the Economy and Climate[18] has estimated (conservatively) "that bold action [on a range of sustainable policies and investments] could yield a direct economic gain of US$26 trillion through to 2030 compared with business-as-usual." In specific areas also considered by the working group, such as smart city, the report found that smarter urban development could yield savings of up to US$17 trillion by 2050; while a shift to more sustainable forms of agriculture combined with strong forest protection could deliver over US$2 trillion per year of economic benefits – beyond improvements to the environment, employment rates and human health.

These strong statements of latent opportunity beg the question, if there is so much to be gained, why is there so much delay on efforts to drive sustainable outcomes? The Global Commission's response to this question points to a failure of government policy and leadership; with an eye trained on the enterprise and mid sized government organizations, the working group has focused on the need to develop and propagate best practises in the deployment of sustainable technologies from institutional, organizational and cultural perspectives. Unlike the technology use cases described above, which dig into the best practices that support the deployment and socialization of IT-enabled sustainability initiatives within specific sectors, the working group has found similarities in need and behaviour across industries. In particular, the group has identified an "abstraction gap" between tactical, near term operational objectives and the longer-term planning and strategy that must be bridged in order that sustainability be fully integrated into efforts aimed at organizational success. While technology may vary by vertical, company and/or jurisdictional need, the approaches used to build momentum in the push to

[18] Unlocking the Inclusive Growth Story of the 21st Century. Accelerating Climate Action in Urgent Times. The 2018 Report of the Global Commission on the Economy and Climate. https://newclimateeconomy.report/2018/

achieve better and more sustainable results are remarkably consistent. According to the working group, outcomes may be improved through enterprise wide activity in the following areas.

Build awareness

Labelled under different umbrella terms, knowledge of the environmental benefits that can be won through the application of sustainable technologies within IT operations and to other organizational systems has been available for some time now. 'Green IT' was the subject of many learned studies – and the source of substantial energy savings and efficiency improvements in the data centre and in peripheral portfolio management – a decade and a half ago; 'smart systems' have since evolved that rely on the analysis of data to optimize operation across a range of departmental systems and functions; and most recently, these efficiency gains have been augmented through sensor technologies that extend instrumentation to new objects in the physical world – the Internet of Things offers additional opportunity to optimize through the ubiquitous collection and analysis of data and the development of automated responses to data inputs. Like the technology itself – virtualization, cloud, smart data centre infrastructure, new cooling methodologies, and AI/ML and analytics-driven software that can improve resource management – information on what can be achieved through sustainable initiatives has been accessible to businesses that are willing to invest time and resource in optimizing operations. However, in many organizations, sustainability is not part of strategic or even tactical discussions. And in some cases, businesses do not realize that the actions they have already taken can be viewed through a sustainability frame of reference: the use of technology that consumes less energy, or produces less carbon, for example, is often considered a means to cost cutting alone.

Finding the right people within the organization – individuals who are invested in sustainability outcomes – is important to awareness building. In data centre modernization, for example, sustainability approaches and messaging may be better received by individuals who must manage energy costs within departmental budgets – facilities managers, rather than IT managers who may be more concerned with server density than energy conservation. Similarly, executives with audit and compliance responsibility may be more interested in analysis of operational data than production managers, and capacity planners within utilities may have unique interest in demand management systems. Ultimately, the goal is to encourage information sharing between groups like these to find common solutions that can address departmental priorities while delivering value to (and beyond) the business.

Takeaway: Building awareness addresses the abstraction gap by aligning the benefits of sustainability to specific issues and concerns, and by illustrating the scope of issues that are addressed by sustainability/related initiatives.

C-suite support

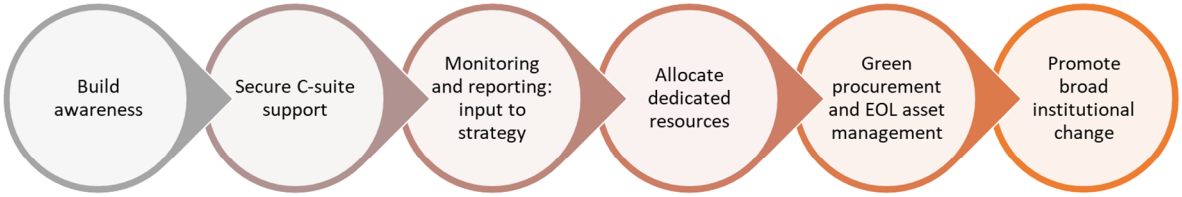
With broad insight into all operations and a mandate to secure the health of the organization as a whole, C-level corporate executives are ideally positioned to champion sustainability initiatives. However, these executives must balance many competing demands, and many don't have an existing understanding of the nexus between financial and operational benefits and sustainability outcomes. According to the working group, to build C-level support, it is critical to align the executive's aim in technology implementations – operational savings, expanded/global reach, scalability, headcount reduction or the control of CAPEX – with sustainability outcomes, and more specifically, to create communications that establish visibility for the linkages between sustainability and the bottom line.

Once this consciousness is developed within management groups, it can be more effectively leveraged: with the authority to set the planning agenda and establish investment priorities, executive leadership can elevate the sustainability discussion to the board level, acting as sponsors for key activities.

In addition to the this 'carrot', the working group advises that the 'stick' also play a role in building awareness around sustainability imperatives within top leadership. In many jurisdictions, actions may be brought against board members for the not living up to their fiduciary responsibilities in addressing all risks and opportunities the business confronts, including sustainability issues.

Takeaway: Developing awareness of the connection between business objectives and sustainable practices addresses the abstraction gap by linking sustainability initiatives to desired outcomes, encouraging C-level executives to lend support to policies that tie to sustainability.

Figure 8. Moving beyond the 'abstraction gap'



Source: TCBC/InsightaaS, 2018

Monitoring and reporting as input to strategy

The working group believes that clear, measurable policies are essential to achieving buy-in to sustainability strategies from C-level executives and from other stakeholder groups. Historically, sustainability has been hard to measure, and as a result, staff members can be reluctant to identify with an approach that does not deliver against performance-based criteria. One of the challenges to demonstrating gains attributable to sustainability or carbon reduction lies in difficulties capturing the data that will provide the foundation for metrics that in turn can make progress visible to project managers and executive sponsors. However, as Figure 1 indicates, there are now many ways that advanced technology can be used to align monitoring and reporting with sustainable business objectives. Each of the tools and approaches highlighted in the Figure – *real-time IoT input*, *advanced analytics and visualization*, *multi-platform delivery to multiple constituencies*, *continuous improvement* and *use of artificial intelligence (via automated or augmented systems)* can be used to support key sustainability objectives by delivering improved monitoring and reporting on operational impacts, which in turn are deployed to engage external ESG ratings and stakeholders.

Typically, organizations will have very short – one-to-two year – planning cycles for contracts, vision, and future direction. But to make effective use of data and reporting from new and emerging technology platforms, the working group recommends that businesses set longer term horizons, even if the actual resources needed to execute on a specific implementation plan are not available today. With a five-to-seven-year planning horizon, the organization will apportion adequate time to obtain information,

develop a baseline, effect change, capture the evidence of change, report on progress, and then benefit from insights that are generated through monitoring. The broader vision that better sustainability planning enables can help address key organizational requirements that may not be top of mind in the initial technology implementation: better metrics on carbon reduction, for example, translate to more compelling messaging around corporate citizenship, while delivering marketing benefits based on higher level positioning with employees, customers and investors. By building sustainability planning into corporate strategy, the organization may also reduce operational risk of non-compliance with regulation, and risk to operational viability. For example, in cases where an important product resource is expected to experience future scarcity, the organization can introduce proactive measures to guarantee supply, to optimize resource use, recycle, institute zero waste policies (which has the added benefit of reducing disposal costs) or to target R&D at finding alternate materials.

The weight of these considerations in strategic planning will depend on the organization's unique circumstances. While many industries are regulated, the list of those industries that are regulated from the perspective of environmental performance (extraction, utilities, etc.) is shorter, and the legal need to address sustainability requirements is not universal. Similarly, many businesses are privately owned, and may not be as responsive to concerned shareholders or investors as are public entities. But as the working group notes, longer term strategy and sustainability efforts will have impact on the bottom line for these organizations as well: sustainability is just good business, even for smaller, privately-owned companies as it helps them to avoid loss or risk, while realizing new opportunity to optimize operations.

Takeaway: Monitoring and reporting is critical to addressing the abstraction gap, as it demonstrates the current state of operations, identifies opportunities for improvement and quantifies progress over a meaningful timeframe.

Allocate dedicated resources

Organizations can use clear success metrics as a basis for setting goals with specific targets and timeframes. But proper execution depends on the willingness of leadership to dedicate resources to coordinating, monitoring and continuously improving sustainability performance. In many settings, individuals who are tasked with addressing sustainability issues simply have this portfolio added to their existing job responsibilities; sustainability is 'tacked on' to an already-overloaded work agenda.

The working group believes that organizations that build momentum for sustainability dedicate qualified professionals to managing sustainability initiatives – individuals who are accountable for results and incented to drive measurable outcomes. This is true even in organizations that position sustainability only in terms of cost reduction: in these environments, a dedicated sustainability officer with clear mandate can identify efficiency opportunities while also highlighting priorities for broader sustainability-linked operational improvements.

The working group likens the sustainability professional's role to that of the health and safety officer in a large corporation: this individual serves as a management resource who will typically sit outside operations, but who is involved across different business functions and who is responsible for results and for communicating sustainability progress in reports to company executives, employees, regulators and the public at large. Like the safety officer, the sustainability professional's actions may not be the single most important contributor to producing the very lowest cost for a widget, but his/her activities can create an environment that will produce a more competitive organization. With adequate time and

focus, this more holistic approach can be self-reinforcing, as the officer works to institutionalize programs for internal sustainability awareness building and training – to raise consciousness and to explain 'how to' – for the communication of 'quick wins' and longer term outcomes to internal and external stakeholders, and to help to educate the C-suite on the importance of professional leadership on sustainability.

Takeaway: Dedicated resources are an essential attribute of organizations that are committed to addressing the abstraction gap: dedicated resources are able to establish targets, drive and measure achievement and demonstrate the value of sustainability in an organizational context.

Green procurement – the circular economy

While the sustainability professional has a key role to play in leading and managing sustainability initiatives, other departments and individuals within the organization may also influence sustainable performance. Procurement officers, for example, may choose to request information on the environmental attributes of products and services, opting for higher performers to help meet the organization's own sustainability targets and to drive environmental improvements within the supply chain. This approach is closely aligned with principles of the 'circular economy', which aim to design waste out of productive operations and out of product/service consumption. In the circular economy, products are designed and optimized for a cycle of disassembly and reuse, as opposed to disposal or recycle, which may involve large amounts of energy and labour.

Durable products, such as computers, are composed of materials, including metals and most plastics, that decompose slowly and hence are unsuitable for the biosphere. But in IT, it is possible to design products at the outset for reuse, or to design products that will experience rapid technological advance for regular upgrade.[19] Another key principle in the circular economy is the shift from the concept of the consumer to the user. Since products are designed for continuous upgrade or reuse, the savvy buyer can engage in contractual relationships with the supplier that more closely resemble rent than commodity purchase. This shift is especially apparent in the world of ICT, where services ranging from public cloud to printer ink management are now on offer "as-a-service." In the printer ink example, advanced systems not only monitor and manage ink supply, but also (by creating ongoing demand within the user organization for what was viewed as commodity hardware) justify continued R&D within the vendor organization to improve the efficiency of the hardware. Through purchasing policies and preferences that favour lease, rent or sharing whenever possible, buyer organizations can drive sustainable design, while delaying disposal of hard goods that have passed reuse cycles to landfill.

Takeaway: Green procurement of ICT products and services can help the user achieve two sustainable outcomes: the organization may need to account for the environmental impact of goods and services it consumes in its own targets; and it may drive better performance throughout the supply chain. By shifting to rent/lease models outlined in the concept of the 'circular economy', the organization can further reduce its own impact, while rewarding sustainable design in the supplier community.

[19] World Economic Forum. From linear to circular—Accelerating a proven concept. http://reports.weforum.org/toward-the-circular-economy-accelerating-the-scale-up-across-global-supply-chains/from-linear-to-circular-accelerating-a-proven-concept/

End-of-life product management: towards a circular economy approach

There is an inherent link between mounting volumes of end-of-life electronic products, scarcity of key materials needed for the manufacture of new devices, and the growing interest in the benefits associated with a circular economy approach. An important element of circular economy practices is to shift focus from mining virgin materials to building new devices from materials that are efficiently collected and recovered from existing products. Circular economy also involves clear focus on the longevity of products: extending their renewability, reuse, repair, upgrade, refurbishment, etc. This approach has tangible environmental and economic benefits.

In Canada, electronics recycling is managed through a myriad of extended producer responsibility (EPR) regulations, with each province and territory obligating manufacturers, distributors and retailers of electronic devices to be responsible for the end-of-life reclamation and recycling. These programs are managed through the Electronic Products Recycling Association (EPRA), an industry-led, not-for-profit organization that operates regulated recycling programs across Canada to ensure that end-of-life electronics are handled in a safe, secure and environmentally sound manner. EPRA provides environmental compliance to more than 7,000 industry stewards (within Canada and in other jurisdictions), collecting electronics through more than 2,300 drop-off locations. EPRA programs have recycled close to one million metric tons of electronics since the first provincial program was launched in 2007. These recovered materials have been returned to the manufacturing supply chain, reducing the need for virgin resource extraction and decreasing associated greenhouse gas emissions.

Takeaway: end-of-life asset management is an important component of environmentally conscious operation that should be linked to green procurement activities and circular economy approaches. Electronics recycling is managed through EPR regulations, and in Canada with the help of organizations such as the Electronic Products Recycling Association.

Broad institutional change

Despite strong scientific research and empirical evidence of the global impact of climate change, the appetite for government-led institutional change has been held hostage to political expediency in many jurisdictions. The Trump administration's withdrawal of the US in 2017 from the Paris Agreement on climate change mitigation is the most dramatic example: while it shakes the foundation of global climate governance and upsets the process of climate cooperation, the withdrawal speaks to domestic business and political constituencies that mistakenly attribute economic challenges to efforts to regulate climate disruption. It is the working group's opinion, however, that governments which have their population's best economic and health interests at heart will take the 'longer view'.

Responsible governments have a critical role to play in supporting efforts to mitigate climate impacts and in promoting environmental sustainability, which can play out in several ways. At a basic level, governments can lead by example through the adoption of policies and practices aimed at improving internal sustainability outcomes.[20] They can lead through the creation of broad national programs like Canada's Federal Sustainable Development Strategy which aims to encourage cross sectoral

[20] See, for example, former US president Obama's presidential document, which outlines Planning for Federal Sustainability in the Next Decade. Federal Register. Vol. 80, No. 57. March 2015, p. 213. https://www.gpo.gov/fdsys/pkg/FR-2015-03-25/pdf/FR-2015-03-25.pdf

improvements[21] and which supports the achievement of goals set by governments on a global basis to achieve carbon reduction committed to in international treaties. Governments also contribute to the development of environmental legislation that regulates carbon emissions, sets a price on carbon or contributes to the creation of voluntary systems such as "cap and trade" that encourage performance improvements – and which can stimulate the development of 'green' jobs and even entire industry sectors.

In addition to creating mandates, governments provide institutional frameworks for progress on sustainability by insisting on some level of reporting and transparency with respect to status and progress. Governments often use procurement to drive better sustainability outcomes: in RFPs issued to the tech sector, for example, firms that demonstrate sustainability achievement can benefit from targeted weighting on environmental issues – up to 20 percent in some jurisdictions. In Canada, government is the largest consumer of IT products and services, so this kind of policy could help drive significant effort to develop additional sustainability capability.

Sustainability leadership is not restricted to federal governments. In the US, the vacuum created by the Trump administration's rejection of global climate change policy was quickly filled by a coalition of state and city governments and private corporations which renewed their commitment to action.[22] In Canada, many provinces have established their own carbon reduction targets and participate in extra-national, regional cap and trade markets such as the Western Climate Initiative to support these goals. Broad coalitions have also formed at the city level through the establishment of 3P agreements designed to deploy technology that can help to build intelligent communities.[23] Ultimately, the working group advises that broad change on sustainability will be driven to a large extent by public sector inspiration; in the absence of legislation or regulation that can solve the climate crisis, business owners, shareholders and citizens can and should contribute through ongoing innovation in technology for environmental good.

Takeaway: Broad institutional change helps address the abstraction gap by setting the context and regulatory frameworks for sector- and enterprise-level sustainability targets and initiatives. Public sector institutions can and should work closely with private sector organizations to emphasize the importance of sustainability and to ensure that investments in sustainability are recognized in meaningful ways (e.g., through procurement, in the setting of targets and regulations) by government and regulatory bodies.

Metrics and Monitoring

As with any organizational initiative, executive buy-in is critical to initial funding and to sustaining momentum in sustainability activities. As noted above, the most effective means to securing organizational/institutional support is to clearly connect the achievement of environmental policies and

[21] Government of Canada. Federal Sustainable Development Strategy. https://www.canada.ca/en/services/environment/conservation/sustainability/federal-sustainable-development-strategy.html

[22] Oliver Milman. Paris deal: a year after Trump announced US exit, a coalition fights to fill the gap. The Guardian. June 2018. https://www.theguardian.com/us-news/2018/may/31/paris-climate-deal-trump-exit-resistance

[23] Mary Allen (lead analyst). IoValue: Intelligence in Community Ecosystems: An IoTCC Best Practices Document. March 2018. http://businesscloud.to/resources/Library/Best%20Practices/IoT-Intelligence_in_Community_Ecosystems-InsightaaS-Final.pdf

initiatives and economic goals. Increasingly, these financial goals are being interpreted through a wider lens that can be aligned with sustainability objectives. The protection of brand and reputation, for example, is now a line item in statements of corporate net worth for many businesses. Driven by potential damage to sales/marketing efforts resulting from a negative social media campaign – around the environmental or social impact of production – many organizations are beginning to rethink or even reorient operations. The media storm created by activist reporting (for example, the 2011 Greenpeace report on cloud computing)[24], which combined with multiple, negative reviews in the mainstream press[25] to persuade many of the global Internet giants to switch to renewable sources of energy to power their massive cloud data centres[26] is only one example drawn from the IT world. But at the same time, the requirement to demonstrate the alignment of green strategy with business outcomes through the application of quantifiable and reliable metrics is also increasing as public and private organizations come to recognize the impact of performance on a range of emissions, pollution, safety and sustainability issues. Now more than ever, professionals in the field are required to prove their value, to show that whatever plan has been created is being implemented effectively, and to demonstrate how they are contributing to improving the bottom line.

Monitoring objectives

In its discussions, the working group focused on this alignment issue, evaluating monitoring and reporting technologies identified in Figure 1 (real-time IoT input, advanced analytics and visualization, multi-platform delivery to multiple constituencies, continuous improvement and use of AI) in light of their importance to a range of business objectives, specifically the compliance, risk management, cost management, marketing benefit and new revenue streams potential outlined in Figures 3-7. Key observations offered by the group included:

- Many of the technologies listed in Figure 1 have a direct impact on *cost management*; depending on their industry/business context, executives looking for sustainability benefits associated with technology-enabled monitoring and reporting may well find clear, near-term cost benefits from sustainability monitoring and reporting.
- Industry context also has a significant bearing on the extent to which monitoring and reporting delivers compliance-related benefits, and associated risk management benefits. In regulated

[24] Gary Cook, Jodie Van Horn. How dirty is your data? A Look at the Energy Choices That Power Cloud Computing. Greenpeace International. 2011. https://www.greenpeace.org/archive-international/Global/international/publications/climate/2011/Cool%20IT/dirty-data-report-greenpeace.pdf

[25] Stephen Schmidt. The dark side of cloud computing: soaring carbon emissions. The Guardian. April 2010. https://www.theguardian.com/environment/2010/apr/30/cloud-computing-carbon-emissions
Adam Vaughan. How viral cat videos are warming the planet. The Guardian. September 2015. https://www.theguardian.com/environment/2015/sep/25/server-data-centre-emissions-air-travel-web-google-facebook-greenhouse-gas

[26] David Mytton, How green is your cloud? InfoWorld. December 2015

industries, such as mining, transportation/ trucking and utilities, there is a need to demonstrate that the firm is adhering to regulations regarding issues like emissions (are scrubbers working to contain particulates? Are effluent releases within established limits governing quantities and types/concentrations of contaminates?) and testing and maintenance – and to identify and address any problems as quickly as possible. Additionally, the working group observed that businesses often have a desire to go "a little bit above and beyond" current minimum thresholds, as a means of preparing for more stringent future regulations and/or as a source of marketing benefit; in these cases, too, monitoring and reporting is an important input to corporate business objectives.

- From an IT-specific perspective, monitoring and reporting is helpful in shaping and achieving sustainability business objectives chiefly because it highlights the costs associated with inefficient facilities and/or equipment. Businesses that operate data centres – corporations, but especially, cloud, colocation and hosting providers – gain direct business benefit from identifying opportunities to reduce costs by moving workloads to more energy-efficient locations or platforms. In these cases, sustainability is really a secondary benefit, as the primary objective is to reduce power-related costs rather than power-related emissions – but it is an outcome nonetheless. (Parenthetically, discontinuing use of outdated equipment or facilities also has the effect of reducing business risk by mitigating the potential for equipment failure, but this is really a benefit that is tied to operational rather than sustainability objectives.)

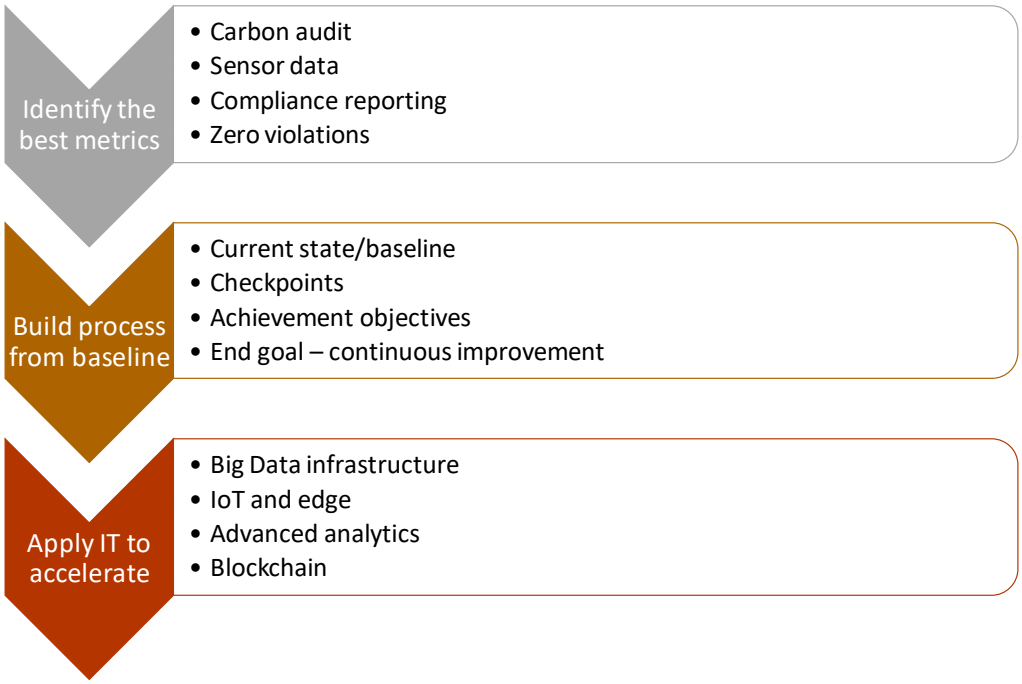
Monitoring and reporting in industrial contexts

In addition to the pipeline example cited earlier in this document, the working group looked at the sustainability benefits associated with technology-enabled (and especially, IoT-enabled) monitoring and reporting in other industrial environments. One example cited by the group was industrial plants, such as pulp mills and smelters. In these operations, predictive and prescriptive analytics offer clear potential to reduce toxic emissions, effluent leakages and other sources of pollution. The working group noted, though, that to best capitalize on these analytics technologies, operators would need to overcome the problem of having large volumes of data sourced from incompatible, 'siloed' systems; they need to aggregate information to provide timely, actionable insights – which can result in management actions taken by humans, machine-to-machine instructions that provide real-time instructions to process control equipment, and/or advanced analyses that combine expert system output with human judgement.

Systems of this sort aren't strictly a means of coping with emergency situations – in fact, a large part of the value associated with these systems is providing a factual basis for proactive policy or process improvement. Monitoring and reporting that connects all of a plant's systems contributes to sustainability and financial success in many ways: it delivers information that drives efficiency and improves cost and risk management, enabling the plant operator to focus investment dollars and innovation on best-return targets

One group member observed that "risk management is where people start with sustainability, but they quickly realize that it's so much more – it's demonstrating to the market that you have the ability to be viable" in a future where sustainability is a key criterion for consumers and investors. This is especially important in industries like oil and gas, mining, energy and industrial facilities, where pollution is visible and known to be extensive, and where operational improvements can deliver significant environmental and cost benefits.

Figure 9. Using metrics to accelerate sustainability outcomes



Source: TCBC/InsightaaS, 2018

Types of metrics

If the range of benefits that sustainability can deliver to improve the bottom line is broader and more interconnected than is generally understood, the range of metrics that can demonstrate improvement is as diverse and numerous as sustainability use cases themselves. At a technology level, the carbon audit served as an important means of measuring the carbon footprint of operations, and more that one Canadian tech startup proved successful in building software tools that were used globally to establish environmental impact. Based on simple algorithms, carbon calculators took simple energy consumption inputs such as staff headcount, number of computers, number of servers, server locations, and the types of servers used to provide a baseline outlining how IT was contributing to carbon emissions, which could be visualized and reported. Other calculators included metrics around energy consumed by physical plant or employee activities, e.g. airplane trips vs. web conferences for staff or client meetings. Used by many government and mid-sized organizations, the carbon calculator aimed at producing an audit that was quantified and standardized – allowing for cross-organizational benchmarking and progress measurement.

There are many other (and many more complex) examples of sustainability metrics that are used to demonstrate the environmental performance of processes, facilities and entire organizations. Beyond mandated metrics captured for reporting in regulated industries, other voluntary systems emerged a decade and a half ago, such as the Carbon Disclosure Project, a global disclosure system that specifies

ways of collecting and reporting GHG emissions. This year, 6,300 companies and 500 cities disclosed GHG information to the CDP.[27]

In addition to carbon reduction metrics associated with energy consumption, though, are a host of other metrics that can also translate to financial and environmental benefit. For regulated industries, zero violations is a positive affirmation of compliance that can deliver results to the bottom line (no fines), while zero injuries is a similar measure of workplace safety. Metrics around the use, transport and disposal of toxic materials are also designed to addressed to meet regulatory requirements; reporting to ensure the sustainability of the supply chain may be a key input to an organization's own performance in regulatory and voluntary reporting. As the working group notes, indicators of sustainability are often unique to the industry or business that is looking to transform. In oil and gas distribution, for example, drones are being used to monitor for issues that might compromise humans and to develop more accurate timing of maintenance activities, while 3D imaging is used to measure shifts in the landscape that might impact pipeline infrastructure.

The process

In broad terms, sustainability strategy will begin with baseline metrics that identify current state across one or more areas that the organization has targeted for improvement. But to support implementation, good strategy will involve a discussion of targets for improvement in specific timeframes. The working group advises "a brutal look" at current state, and the creation of a program that will take a critical view of operations, set a baseline and establish end goals, define checkpoints and achievement objectives. Structured plans for developing a sustainability program will typically specify a constant cycle of 'create', 'modify' and 'measure' in which the organization continues to retune and improve both operations and the sustainability program. Advanced organizations may establish a centre of excellence to drive this process of continuous improvements.

Determining where to begin presents another challenge. In many organizations, managers may compete to establish priority for their own project. In this scenario, a senior executive may need to decide within the corporate context, which project would address the biggest issue for the organization. Another tactic, which may complement executive decisioning, is to focus on the surest 'quick wins' that will reinforce the viability of sustainability programming by returning measurable results in a timely fashion. This approach also helps to identify the project manager/sustainability officer with success, and when results are communicated throughout the organization, including to senior management, helps to build momentum for enterprise-wide strategy.

Applying technology

Technology is a critical component in sustainability planning and execution. As IT enables organizations to move from reliance on anecdotal evidence of improvement through data-driven monitoring, it delivers better, faster and more direct reporting of quantifiable results. And through use of advanced analytics solutions, organizations can move beyond historical measurement to predictive activities, incorporating additional data sets – factoring in, for example, additional or external metrics on pollution control, on measures to improve sustainability or climate or other risk factors that can help fine tune next steps.

[27] CDP. About us. https://www.cdp.net/en/info/about-us

Across all fronts, technology innovation is helping to drive continuous improvement in sustainability processes. While the instrumentation of business and industrial systems in IoT deployments is generating massive new data that can serve as the source of insight for new opportunities in the cycle of efficiency and other operational improvements, application development is creating new levels of convenience and control in systems monitoring and reporting, and advances in cloud and software-defined IT infrastructure are providing the data management foundation needed to support increasingly sophisticated, data-intensive sustainability solutions.

In summarizing its monitoring and reporting discussion, the working group noted that the "plethora of data" arising from instrumented systems is itself a significant issue. How can organizations assemble many different data sources into a base of evidence that can be used to inform sustainability discussions, identifying opportunities to capture new or enhanced benefits? Carbon trading offers a case in point: there are opportunities to drive marketing benefit and new revenue sources from trading systems, but these rely on analysis of data that may be difficult to aggregate (because it is obtained from multiple, potentially 'siloed,' systems) and process (because it is voluminous, varied in terms of format and source, and may be delivered in continuous streams that require rapid ingestion). Another area where advanced IT may support a more holistic assessment of sustainability is in life cycle assessment of a particular product or service. Measurement across this continuum – spanning the impact of sourcing materials for production, actual processing, product use and disposal – involves multiple inputs; cradle-to-grave assessment presents Big Data volume and integration challenges that rely on advanced technology solutions, but better data analysis and the increasing programmability of process and distribution systems will enable the continuous evolution of more, and larger sustainability initiatives.

For organizations that may be reluctant to embark on a program of sustainability management for its own sake, the instrumentation and combination of data from multiple systems including human, operational and the environment may represent a compelling proposition, as shared systems can offer additional opportunities for improvements. For example, by providing real time data on production, along with the ability to respond immediately to issues through data-driven control systems, Industrial Internet applications can optimize operation to generate new kinds of savings. Today, real time response is needed and available to create exponential, as opposed to incremental, improvements, that provide the basis for real contributions to the organization's bottom line.

If instrumentation in Industrial Internet deployments enables advanced asset tracking across the product lifecycle, a key challenge in this exercise has been transparency in reporting – an issue that continues to dog sustainability initiatives generally. To be effective, reporting must be reliable and accessible to all stakeholders. Today, emerging technologies, such as Blockchain, are helping to resolve this issue. Based on a distributed leger technology, Blockchain creates an immutable record of transactions to ensure the validity of an outcome or result, and can deliver visibility across multiple constituencies. Such a record has immense potential in a sustainability context; the working group notes, however, that the value Blockchain offers will be realized only when organizations agree on a standard of measurement. Like other reporting mechanisms, Blockchain can deliver transparency and visibility, but organizations in the supply chain will also need third party, regulatory validation of inputs to ensure that the data that is being entered into the ledger is not corrupt.

Conclusion

Looking forward, technology innovation offers huge promise to address many of the issues in sustainability programming, and to accelerate improved environmental outcomes – even in challenging political climates. Emerging IT-enabled capabilities, including ubiquitous measurement and self-learning AI, are poised to deliver new support for rapid advances in sustainability, as machines automate process improvements at a pace that was unthinkable a decade ago. This prospect provides sound cause for optimism about the progress of sustainability outcomes, which in the past have fallen victim to short-term political or business priorities. Technology is now used to simplify data acquisition, for analysis of sustainability initiatives, to improve accountability and reportability and to speed cycles of improvement, within organizational and productive processes, within product design, and in the consumption of service offerings. The challenge now is to ensure these approaches are recognized as important in diverse business contexts, standardized and reproducible, and socialized so that they are accessible to the enterprise and the small and midsized business alike.

Technology to support sustainability programming and performance has been available for some time; as it becomes more secure, more reliable, faster and more affordable, the continuous alignment of sustainability objectives with political or economic goals can produce the "organized will" needed to move the needle on sustainable innovation faster than the pace at which it moves today. In the absence of political leadership and as the world moves closer to climate Armageddon, businesses of all sizes across Canada will need to reorient visions of sustainability activities from CSR statement to operational imperative.

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Sponsoring members and contributors

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The IoT Coalition Canada gratefully thanks our corporate members for their support:

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About InsightaaS

Dedicated to exploring "the 'why' in enterprise technology," InsightaaS was founded by Mary Allen and Michael O'Neil in 2013. The company operates Canada's deepest IT content website and provides strategic consulting and channel management guidance to leading firms in Canada, the US and abroad.

In 2015, InsightaaS launched the Toronto Cloud Business Coalition, a community dedicated to the co-creation of Best Practice guidance designed to accelerate adoption and use of cloud in Canada. The tremendous success of the group has spawned four additional communities – IoT Coalition Canada, Canadian Analytics Business Community, DC Foresight and V2V: The Economics of Data, plus the CIA-Plus, V2V, DC Foresight and Transformative Technologies meetup communities. These groups continue to help Canadian businesses to capture value from advanced technology.